3.0 SENSITIVITY ANALYSIS

As described in the SMART accreditation support framework document [1], sensitivity analyses consist of running a simulation over the expected range of inputs to determine:

a. the reasonableness of changes in function-level and overall model-level simulation outputs to changes in function-level and model-level inputs,

b. critical simulation functions for the purpose of prioritizing subsequent V&V activities as appropriate to intended applications, and

c. data collection parameters critical to the usefulness of collected data for the validation of each prioritized functional element.

This approach implies that the functional elements (FEs) were well-defined during the Phase I decomposition and that the code for each FE can be identified and extracted. The reason for this decomposition is that very often, inputs and outputs at the FE-level are not inputs or outputs at the model-level. Therefore, in order to examine FE-level sensitivities, the code associated with the FE of interest must be extracted and off-line drivers must be developed to vary the input parameters. Model-level sensitivities, on the other hand, are examined by varying available inputs and running the simulation as distributed.

One problem impeding the sensitivity analyses for EADSIM is that the simulation is distributed without compilable source code. This precludes the extraction of code associated with individual FEs and the detailed examination of FE-level sensitivities. This is less of a problem for mission-level models, such as EADSIM, than for higher-resolution, engagement-level models, because overall, there is less detail in the individual FEs, and many of the FE inputs are also model-level inputs. For this reason, the sensitivity analyses described in this section only examine model-level sensitivities.

Another problem with sensitivity analyses for mission-level models is that the sensitivities are very scenario-dependent. For the analyses reported here, one or two systems which represent the FE being examined were selected, as e.g. the BAR-LOCK(B) and AN/APY-1 radars for the RF sensor FE. Model-level sensitivities will strongly depend on the number and role of these sensors in the chosen scenario. If there are many sensors of this type or they serve a critical function in the scenario, the model sensitivity will be high. If there are only few of these sensor types or they are non-critical, model sensitivity will be low.

3.0.1 DEMO300 OVERVIEW

The goal of the sensitivity analyses is to determine relative model-level sensitivities for all the FEs examined in a fairly complex, many-on-many scenario. Rather than developing a new scenario, the unclassified Demo300 scenario which is distributed with EADSIM was used. Demo300 is a cold-war combat scenario between US and Soviet forces in the Fulda gap region of central Germany. The US forces consist of various ground and airborne platforms defending against an attack by Soviet aircraft and ballistic missiles. System types from Demo300 are listed in Table 3.0-1. All data in this scenario represent notional capabilities rather than actual system capabilities and are unclassified.

TABLE 3.0-1. Demo300 System Types.

System	Number
US Air Systems	
F-117A(STEALTH)	1
F-15	22
F-15(escort)	2
JSTARS A/C	1
NAEW	1
SAT	1
US Ground Systems	
ABMOC	3
Avenger	9
BDEFDC	1
BLUEAIRFIELD	1
BNFDC	1
ECS	3
GEADGE CRC	1
HAWK	2
ICC	1
INTEL-CENTER	1
MLRS	4
MLRS BN FDC	1
MLRS BTRY	2
MLRS-M	1
SENSOR/C2	4
THAAD BN	1
THAAD_FU	1
Soviet Air Systems	
AN-12(CUB C/D)	1
MIG-23(FLOGGER-B)	16
MIG-23(FLOGGER-B)GA	4
MiG-25(Foxbat-F)(REDWW)	1
MiG-29(Fulcrum-B)	6
Red_ALCM	5
SU-19(FENCER)	8
Su-27(Flanker)S	3
Tu-26(Backfire)	3

TABLE 3.0-1. Demo300 System Types. (Contd.)

System	Number
Soviet Ground Systems	
GENERIC_HOSTILE	3
TEL_SS-21	3
TEL_SS-23	5

Initial force dispositions are illustrated in Figure 3.0-1 against a color-coded terrain elevation map (represented in Figure 3.0-1 as shades of grey). Soviet aircraft are located in the upper right-hand corner of the picture and fly south to engage US aircraft and bomb various targets. Soviet surface-to-surface missile launchers (SS-21 and SS-23) are in the upper left, and the US air defense consisting of ground and airborne surveillance platforms, C2 centers, and various surface-to-air systems is in the lower two-thirds of the figure.

Various measures of effectiveness (MOEs) can be used to evaluate mission-level force effectiveness and depend upon the specific analysis application. The most common MOE used in mission-level analysis is platform attrition, but since this measure aggregrates the effectiveness of numerous lower-level systems and platforms, there is often little sensitivity to individual system changes. For this reason, other MOEs are sometimes more useful for examining specific system characteristics. For the sensitivity analyses presented in this document, a number of different MOEs are used depending upon which are considered most appropriate for the sensitivity being examined.

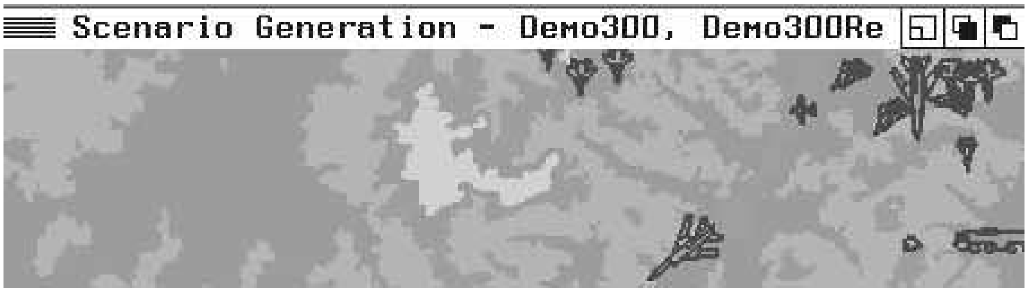

FIGURE 3.0-1. Initial Force Dispositions for Demo300.

3.0.2 SUMMARY OF RESULTS

Table 3.0-2 provides a summary of sensitivities examined and a qualitative assessment of the model-level sensitivities based upon red aircraft attrition in the Demo300 scenario. The sensitivities are categorized as high, medium, or low (H, M, or L).

TABLE 3.0-2. Summary of Sensitivity Analyses for EADSIM.

FE Name	Parameter	Range Varied	Model Sensitivity
RF Sensor	Power	21-60 dBW	M
	Frequency	3.5, 6.0 GHz	L
	Side/Back-lobe Gain	-10/-20 to -30/-40 dBi	M
	Target RCS	10-0.001 sq. m.	M
Weapon	Range	10-30 km	L
	Velocity	600-1600 m/s	L
	Pk	25, 50, 75%	M
Ruleset	Max Assessed Threats	5-20 targets	L
	Repeat Time	10-120 sec.	L
	Assignment Options	Air Over Ground: on/off	L
Network Protocol	Field Length	32-128 bits	L
	Message Size	2-100 words	L
	Purge Time	15, 60 sec.	L

3.0.3 IMPLICATIONS FOR USE

Model sensitivities for mission-level models are very scenario-dependent and are not easily extrapolated from one scenario to another. The results reported in this ASP are based on the Demo300 scenario distributed with EADSIM and reveal no unexpected model limitations or constraints.